



# Physical Changes of Matter

## Teacher Resource Guide

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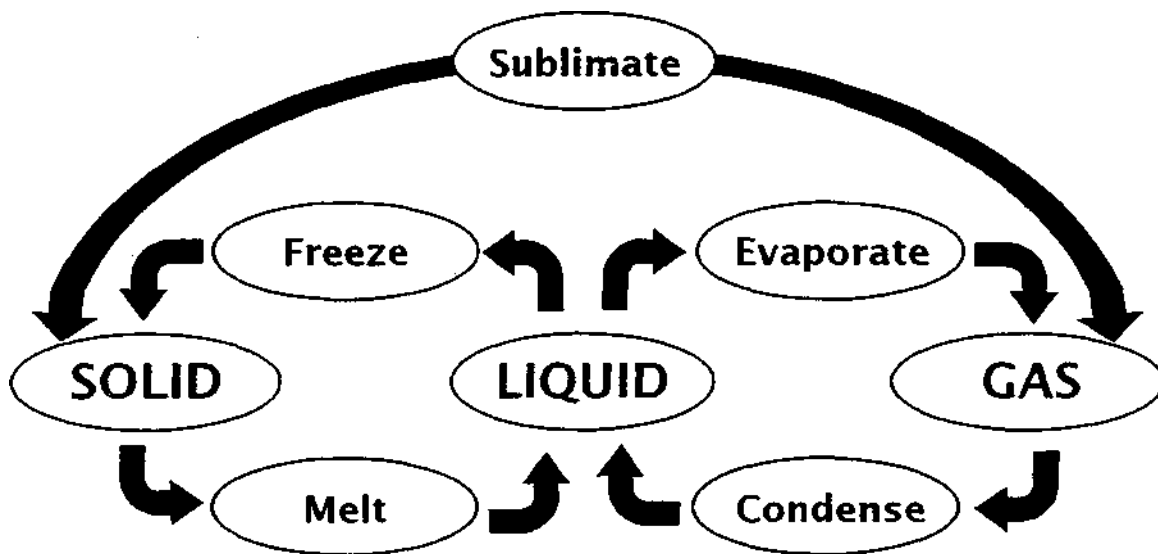
# Physical Changes of Matter

## Phases of Matter

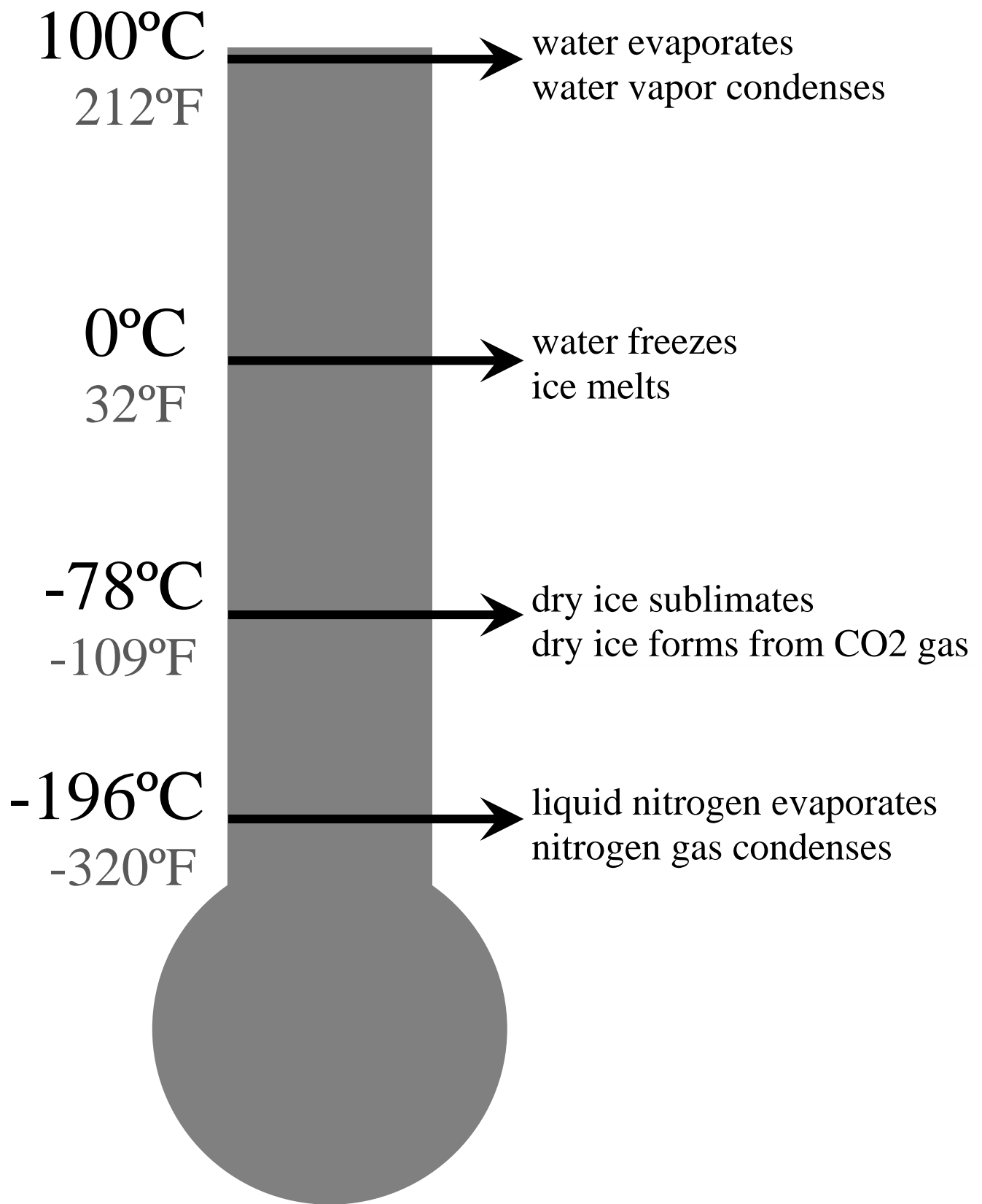
Matter is defined as anything in the universe that has mass (or weight) and takes up space. In other words, matter is "stuff." All matter is made up of tiny particles called molecules. Different kinds of matter are made of different kinds of molecules. When you change matter by changing the kinds of molecules it is made of, this is called a chemical change. There are other kinds of changes that take place when you change the distance between molecules. These are called phase changes.

For example, solid water (ice) has its molecules very close together in a rigid arrangement. These molecules are made from two parts hydrogen and one part oxygen ( $H_2O$ ). Liquid water is also made from the same ratio of hydrogen to oxygen but the molecules are further apart. This way, the molecules can slip over each other and allow liquid water to pour. Water vapor (gaseous water) has the molecules even further apart than liquid water.

Phase changes are usually caused by adding or taking away heat. Molecules respond the same way to changes in temperature as we do. If it is very cold, people tend to huddle together for warmth. When matter is cold, the molecules squeeze closer together. When it is hot, both people and molecules tend to spread out. Phase changes are physical changes of matter from one form to another. By adding or subtracting heat energy, matter undergoes these changes.

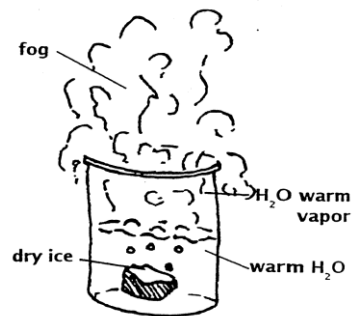


When heat is applied to ice, it will **melt**, producing water. When heat is applied to water, **evaporation** occurs, producing water vapor (a gas). Cooling, instead of heating, will produce the opposite effect. When water vapor is cooled, it will **condense** into water. When water is cooled, it will **freeze** into ice. With any specific material, the solid will melt into a liquid at the same temperature at which the liquid will freeze into a solid. This is known as the melting-freezing point. The same relationship applies to the evaporation-condensation point.



## Dry Ice

Dry ice is carbon dioxide ( $\text{CO}_2$ ) gas which has been cooled and frozen ( $-78^\circ\text{C}/-109^\circ\text{F}$ ) into a solid. When  $\text{CO}_2$  is heated above this temperature **sublimation** occurs. Sublimation is the process by which a solid changes directly to a gas. By leaving dry ice out at room temperature (approximately  $20^\circ\text{C}$ ), it will sublime, having no liquid phase between the solid and gas phases. When dry ice is placed in a beaker of warm water, the warm water will evaporate slowly, leaving a layer of warm water vapor above the water. At the same time, the warm water heats the dry ice above its sublimation point. The cold  $\text{CO}_2$  bubbles rise and hit the warm water vapor above the water. The water vapor condenses on the cold  $\text{CO}_2$  gas molecules like your warm breath condenses on a cold window, producing fog.



## Liquid Nitrogen

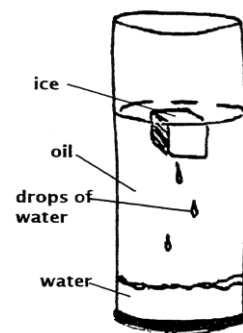
Nitrogen ( $\text{N}_2$ ) condenses into a liquid at  $-195^\circ\text{C}/-320^\circ\text{F}$ . When allowed to warm to room temperature it boils and evaporates. Placing objects in liquid nitrogen causes the molecules of the object to move closer together. Objects that are solid become more brittle. Objects that contain liquid, like flowers and bananas, freeze.

Examples:

- flowers freeze and can be shattered
- inflated balloons contract then expand upon removal from  $\text{N}_2$
- rubber balls become brittle and can be shattered
- bananas freeze
- dry ice causes faster evaporation of liquid nitrogen because dry ice adds heat to liquid nitrogen

## Physical Change to Try at Home

An ice cube in corn oil can demonstrate how phase changes affect physical characteristics. When an ice cube is placed in a clear container (tennis ball can) of corn oil, it floats just below the surface. When the ice cube melts, water droplets sink through the oil to the container bottom. As the ice changes from the solid phase to the liquid phase, its density increases. Density is the ratio of an object's mass to its volume. Water is more dense than oil, but ice is less dense than oil. Most objects get more dense as they cool and freeze. Water is an exception to this rule.



## Resources

- Online Resources
  - Chem4Kids [Matter](#) and [States of Matter](#) info pages
    - [http://www.chem4kids.com/files/matter\\_intro.html](http://www.chem4kids.com/files/matter_intro.html)
- Lower Elementary (K-3) Print Sources
  - *Matter: Physical Science for Kids*, Andi Diehn, Nomad Press, 2018
  - *What is the World Made Of?: All About Solids, Liquids, and Gases*, Kathleen Zoehfeld, Harper Collins, 2015
  - *What's the Matter in Mr. Whisker's Room?*, Michael Elsohn Ross, Candlewick Press, 2007
  - *Many Kinds of Matter: A Look at Solids, Liquids, and Gases*, Jennifer Boothroyd, LernerClassroom, 2011
- Upper Elementary (4-6) Print Sources
  - *Eyewitness Science: Matter*, DK Publishing, New York, 1992
  - *Matter Matters!*, Tom Adams, Templar, 2012
  - *Changing Matter: Understanding Physical and Chemical Changes*, Tracy Maurer, Rourke Publishing, 2012